New Zealand

"KIWI for kids"!
A simulation-based knowledge laboratory on the early life-course

Internal Seminar
SSRU, Institute of Education
4 June 2014

COMPASS RESEARCH CENTRE

FACULTY OF ARTS
THE UNIVERSITY OF AUCKLAND
Whare Wānanga o Tāmaki Makaurau

Peter Davis and Colleagues
COMPASS Research Centre
University of Auckland
New Zealand
www.compass.auckland.ac.nz

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HIKINA WHAKATUTUKI

The University of Auckland

Outline

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- Introduction
  - The team – KIWI and projects
  - The product – micro-simulation (early life-course)
- Construction
  - The “end-users” – policy advisers
  - The inquiry system – central ingredients
  - The process – building the inquiry system
- Application
  - Assessing the “social determinants of health” model
- Extension
- Conclusion

COMPASS Research: The Team – and KIWI

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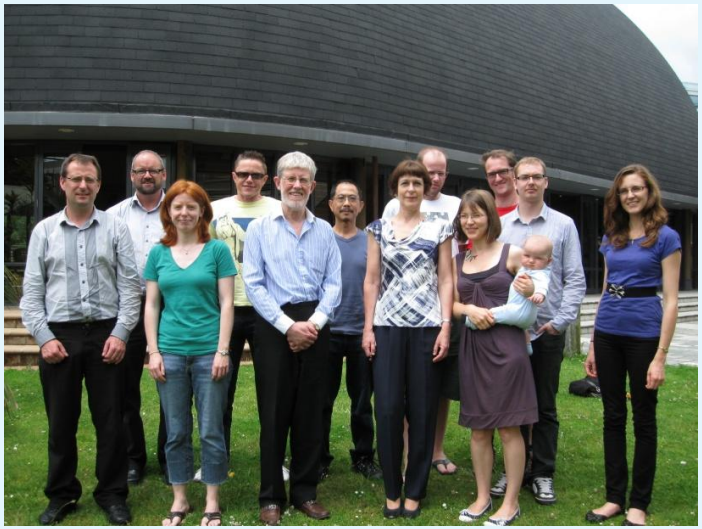
- ~10 years, $ 1 million p.a., grant-funded
- 5 contract staff, usually 3–5 graduate students
- Big user of existing data: (i) analysis, (ii) modelling
- For our micro-simulation projects we draw on:
  - Two research fellows, two statisticians, a data manager/programmer

Knowledge "laboratory"

Inquiry system

With

Intervention/policy modelling



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Projects: Key simulation models

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- 1. Care systems – data from multiple sources
  - Primary care (family doctor) system
    - Models the role of the "family" doctor
  - Balance of care systems
    - Extends model to incorporate other care elements
- 2. Life course – data from longitudinal studies
  - Early life course (childhood)
    - Uses existing cohort studies for ages 0-13
  - Later years
    - Uses existing longitudinal studies for over 65s

The Product: Micro-simulation.

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- We start with a sample of individuals
  - Real (studies) / synthetic (derived from Census)
- We derive statistical rules to create a 'virtual cohort' through to age 13
  - Derive rules best able to reproduce study data
  - Apply these rules to the base file to create a synthetic sample of children with typical biographies
- We then simulate what might happen if policy were to change, by altering parameters
  - Using software application

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The “End Users”: Policy advisers

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- End Users Group:

  Ministry of Social Development (MSD)

  Ministry of Health (MoH)

  Ministry of Education (MinEdu)

  Ministry of Justice (MoJ)

- Drive development
- Collaborative approach
- Suggest scenarios

Scenarios to test

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1. Are children in households where both parents are working better off?
2. How does smoking in pregnancy affect later outcomes?
3. How can we improve early literacy, school achievement and reduce failure in the job market?
4. How does single parenting affect later conduct problems?
5. What interventions have impact on later (health, wealth, social, education, justice) outcomes for Māori, Pacific or low-socio-economic status groups?

The Inquiry System: six key ingredients

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- Knowledge "laboratory" inquiry system (KIWI)

1. A synthetic base file representative of the population
2. A number of real-world longitudinal studies
3. A technique for combining the data from 4 studies
4. A statistical model mimicking life-course biographies
5. A tool that helps interrogation of these biographies
6. [Parameter estimates drawn from the literature]

1. Synthetic Base File

(this work due to Barry Milne)

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- Subset NZ 2006 Census to include just new-borns (0-year olds) and their parents
  - Randomly select 10,000 (from 50,000)
- Calculate distance (Euclidean) between each of the 10,000, based on 52 Census characteristics.
  - Done separately by family-type
- Choose the closest 2 ranks to form 10,000 clusters of 3 individuals

Methods

- Randomly choose which "real" child's characteristics are used for each synthetic one
  - Characteristic by characteristic

	Cluster of 3 Children		
Characteristic	Child 1	Child 2	Child 3
Child sex	Male	Female	Female
Mother age	29	41	31
Father age	32	40	38
Home ownership	Owned	Owned	Rented
Deprivation score (1-10)	9	7	8

Methods

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- Randomly choose which "real" child's characteristics are used for each synthetic one
  - Characteristic by characteristic

	Cluster of 3 Children			
Characteristic	Child 1	Child 2	Child 3	Random Draw {1,2,3}
Child sex	Male	Female	Female	2
Mother age	29	41	31	1
Father age	32	40	38	1
Home ownership	Owned	Owned	Rented	3
Deprivation score (1-10)	9	7	8	3

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Methods

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- Randomly choose which "real" child's characteristics are used for each synthetic one
  - Characteristic by characteristic

	Cluster of 3 Children				
Characteristic	Child 1	Child 2	Child 3	Random Draw {1,2,3}	Synthetic child
Child sex	Male	Female	Female	2	Female
Mother age	29	41	31	1	29
Father age	32	40	38	1	32
Home ownership	Owned	Owned	Rented	3	Rented
Deprivation score (1-10)	9	7	8	3	8

1. Synthetic Base File

- Voilà! A synthetic base-file of 10,000 composite individuals

2. Four Studies

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- Christchurch Health & Development Study (CHDS)
  - 1265 children born in Christchurch 1977. Followed since
- Dunedin Multidisciplinary Health & Development Study (DMHDS)
  - 1037 children born in Dunedin 1972/3. Followed since
- Pacific Islands Families Study (PIFS)
  - 1398 children born at Middlemore Hospital, 2000, with at least one parent of Pacific Islands ethnicity. Followed since
- Te Hoe Nuku Roa Study (THNR) **[calibration only]**
  - Longitudinal study of Māori households (beginning 1995)
    - Auckland, Wellington, Manawatu, Gisborne, Northland, Southland, Nelson
  - 568 children (0-12) assessed at least twice in four waves

3. Data Integration

(due to Barry Milne and Jessica McLay)

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- Associations between X & Y assessed using longitudinal regression analyses
  - Utilises data from all the ages available from the three studies (THNR not used)

Age	Y_{CHDS}	Y_{DMHDS}	Y_{PIFS}	X_{CHDS}	X_{DMHDS}	X_{PIFS}
Birth	✓	✓	✓	✓	✓	✓
1	✓		✓	✓		✓
2	✓		✓	✓		✓
3	✓	✓		✓	✓	
4	✓		✓	✓		✓
5	✓	✓		✓	✓	
6	✓		✓	✓		✓
7	✓	✓		✓	✓	

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Stack All Three Datasets

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N=3700

4. A Statistical Model

(this work due to Jessica McLay)

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Regression Techniques for Dynamic Micro-simulation:

An Empirical Performance Assessment

- Background
- Aims
- Statistical Modelling Techniques
- Empirical Assessment Methods
- Results
- Conclusion

The Simulation Process

Simulating Reading score: Simplified rule from statistical model:

E[reading score] = 13.00 + .91*reading.score.previous + .07*months.breast.fed +
1.04*father.tertairy.qualification + .87*father.secondary.qualification

	Child A
Characteristics	
Reading score at age 8	40
Number of months breast fed	12
Father's Education	Secondary
Predicted reading score at age 9	`13.00 + .91*40 + .07*12 + .87` = 50.58
Random draw from a normal distribution	50.23
Reading score assigned at age 9	50

Apply Rule

Expected value

Stochastic component

5. Inquiry Tool

(due to Barry Milne)

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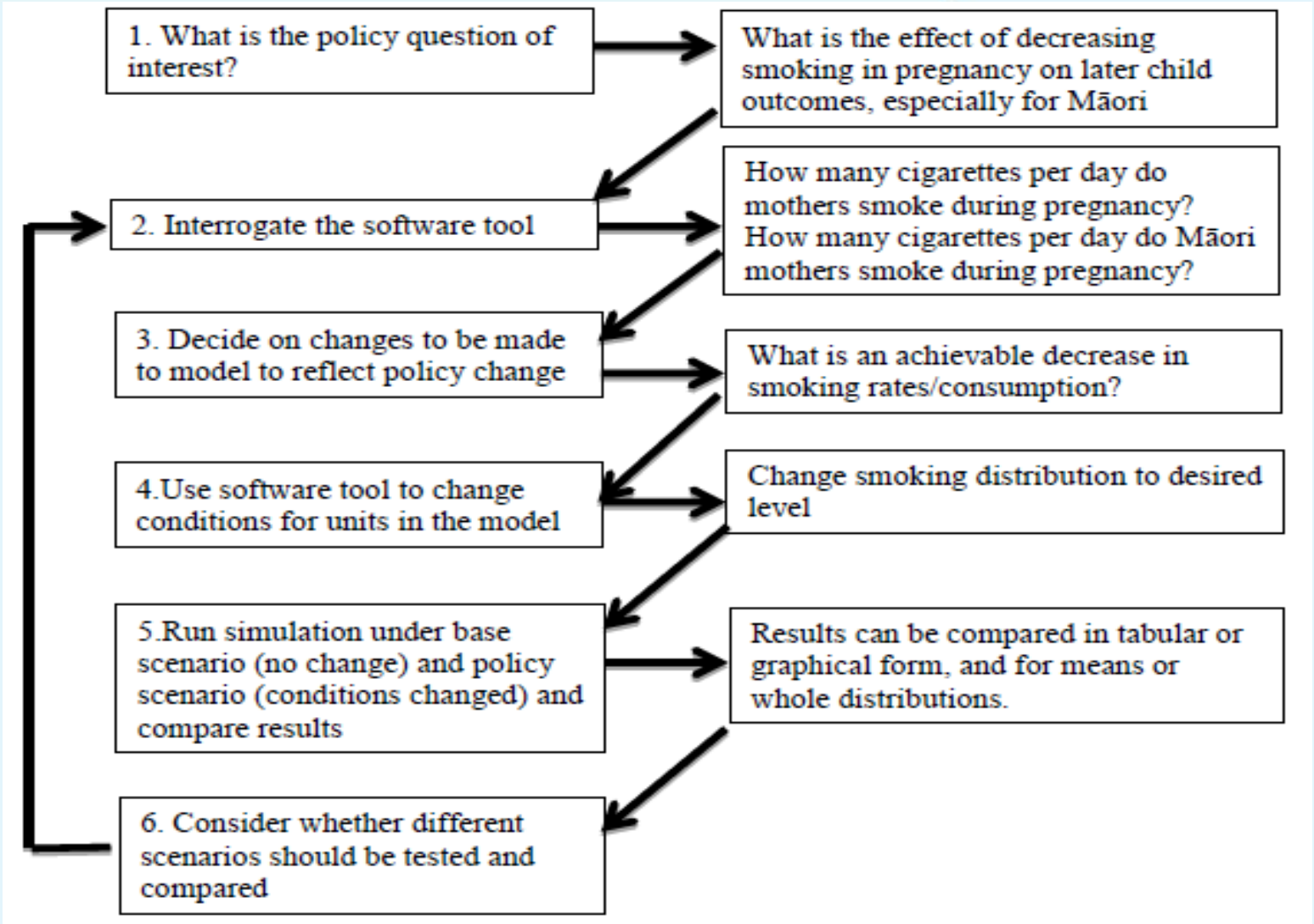

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Assessing counterfactuals

- **Counterfactual paradigm of causal reasoning**
  - If the putative causal factor had not been present, we would not have observed the recorded outcome.
    - Randomised Controlled Trials (RCTs)
    - Experimental and quasi-experimental methods
    - Observational designs and statistical analysis
  - **Simulation techniques**

Research questions

(this work due to Roy Lay-Yee)

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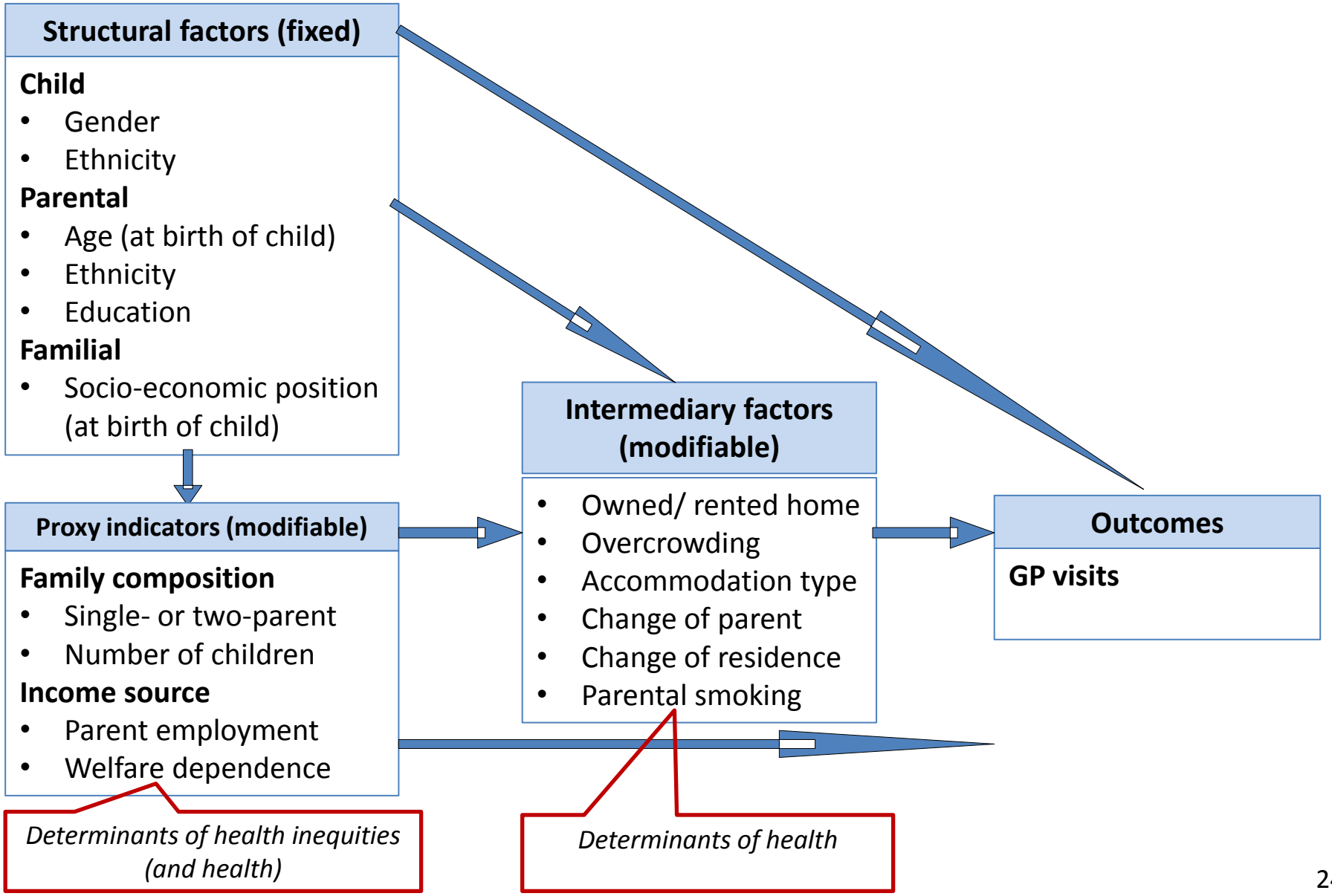
- What is the effect of improving various factors on levels of family doctor (GP) visits among children?
  - Single or multiple factors?
  - Are structural or intermediary factors more influential?
  - Is there greater impact on socially disadvantaged groups?
- (Do the same mechanisms operate for outcomes in other domains, e.g. reading ability or conduct problems?)

Model of structural and intermediary influences on child outcomes



Scenario testing procedure

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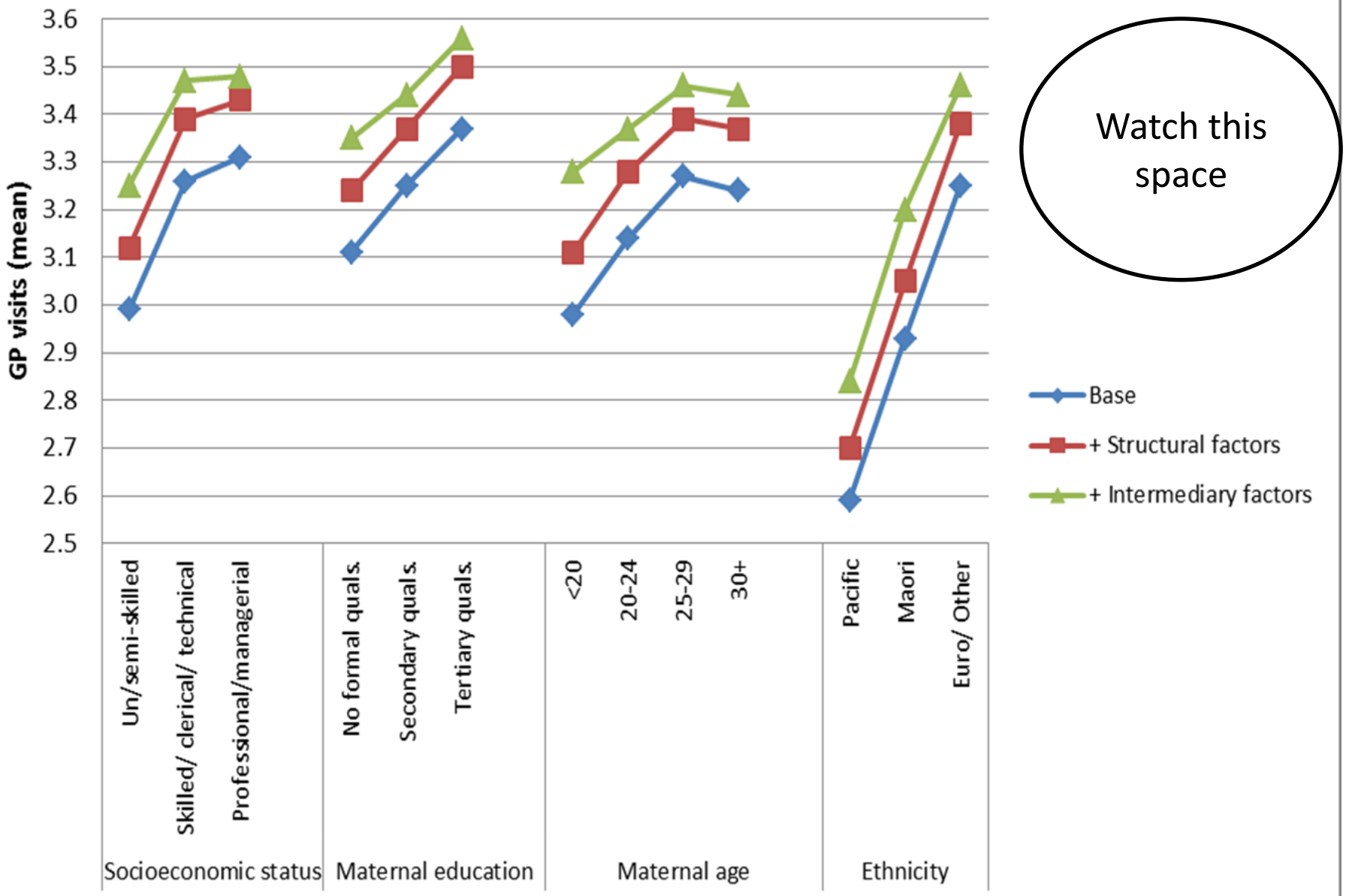
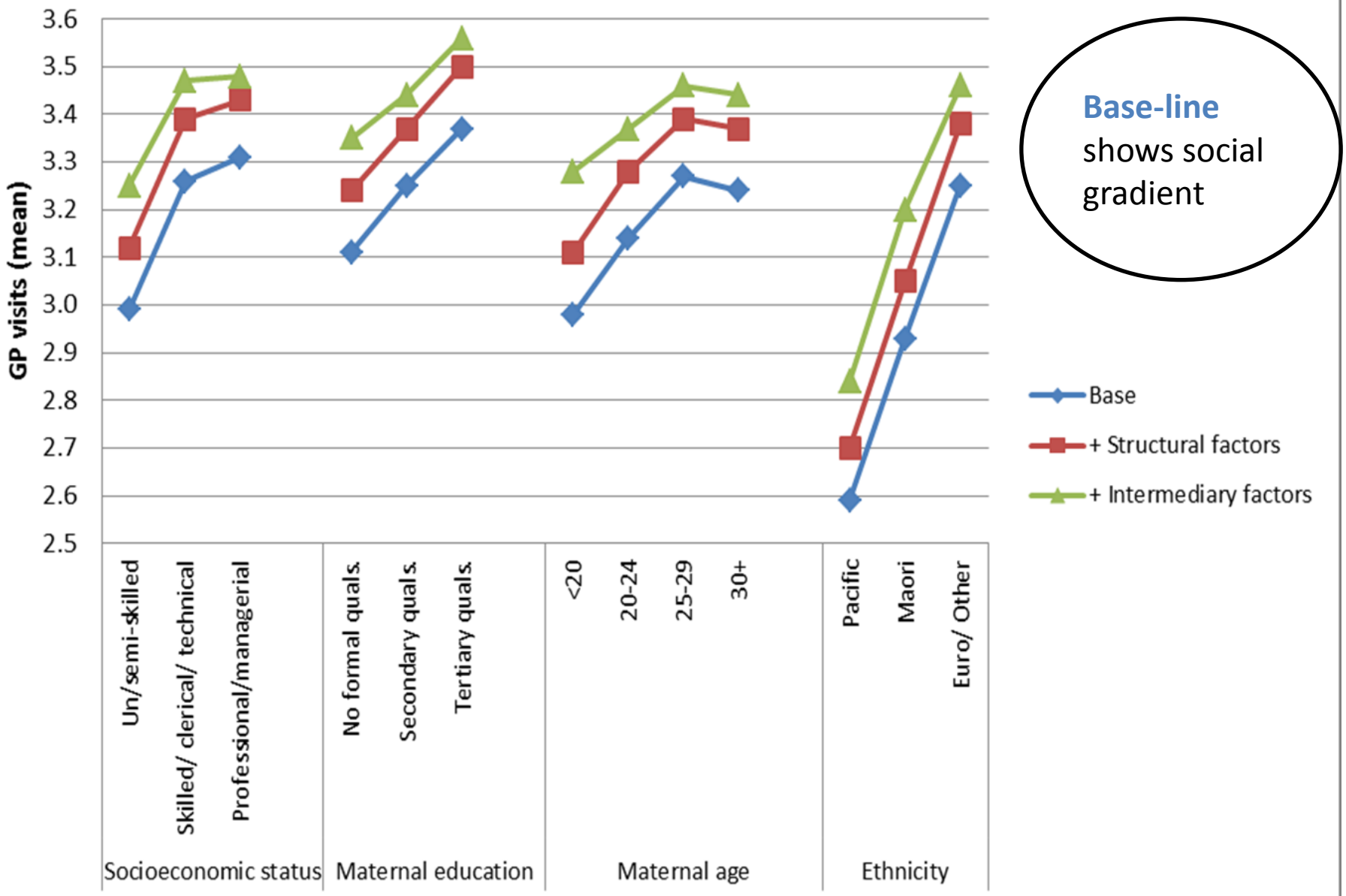
1. We 'improved' *single* factors and assessed the degree of impact on outcome
2. We 'improved' *multiple* factors simultaneously
3. We compared the relative effects of 'improving' structural and intermediary factors
4. We posed 'best case scenarios' by 'improving' structural and intermediary factors *simultaneously*

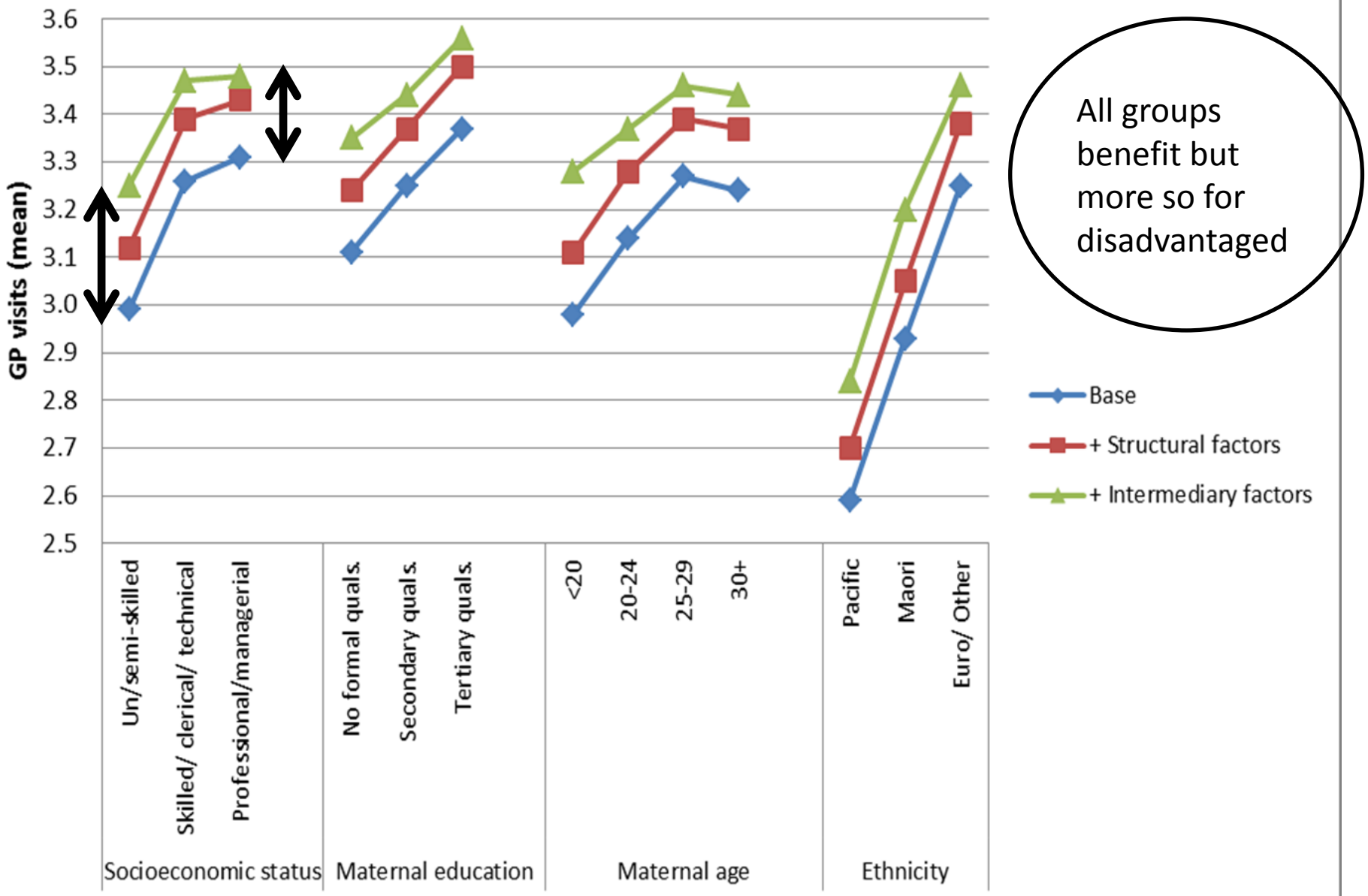
GP Visits. Disparities: absolute change



GP Visits. Disparities: absolute change



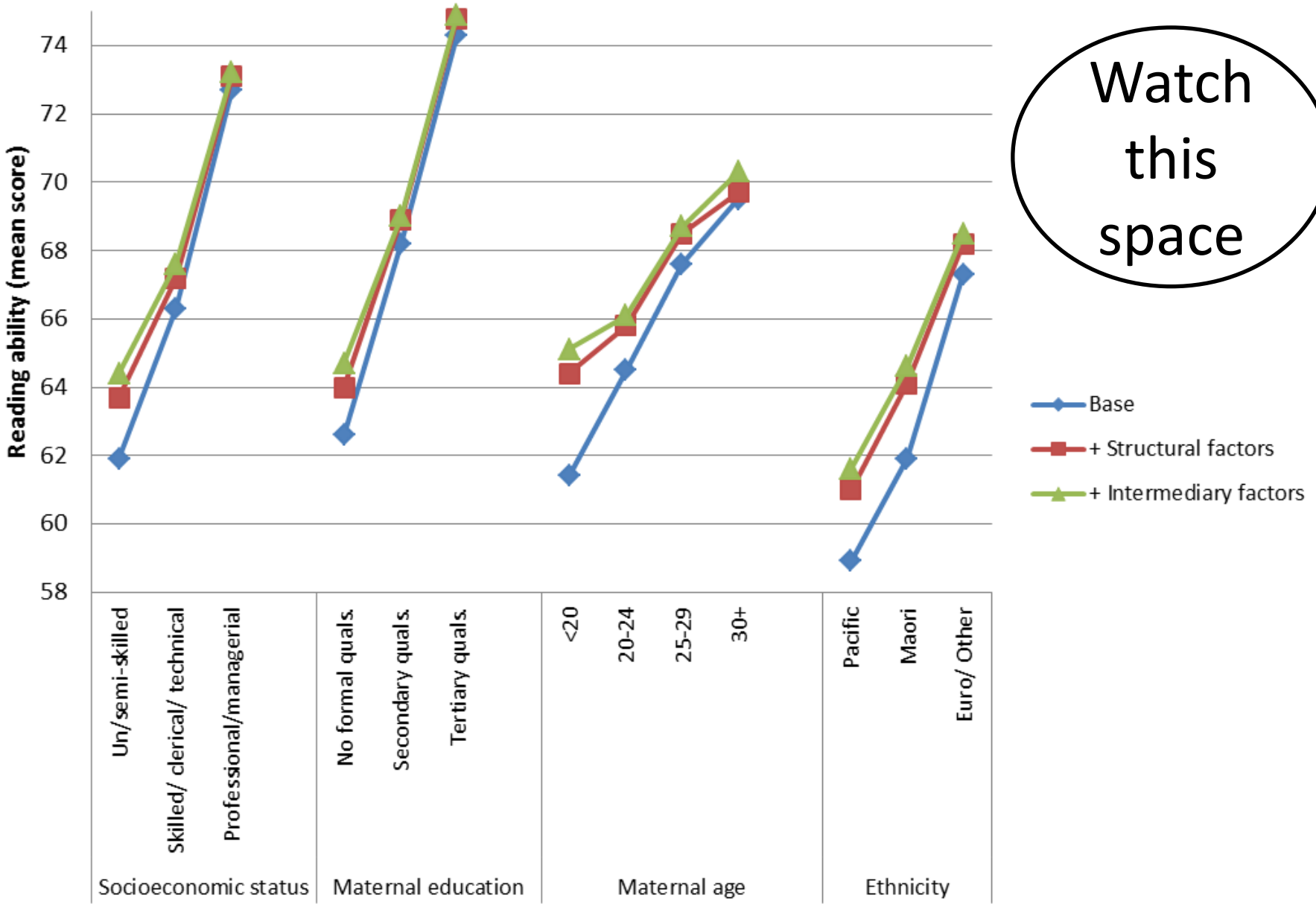
GP Visits. Disparities: absolute change



Outcome: Reading ability

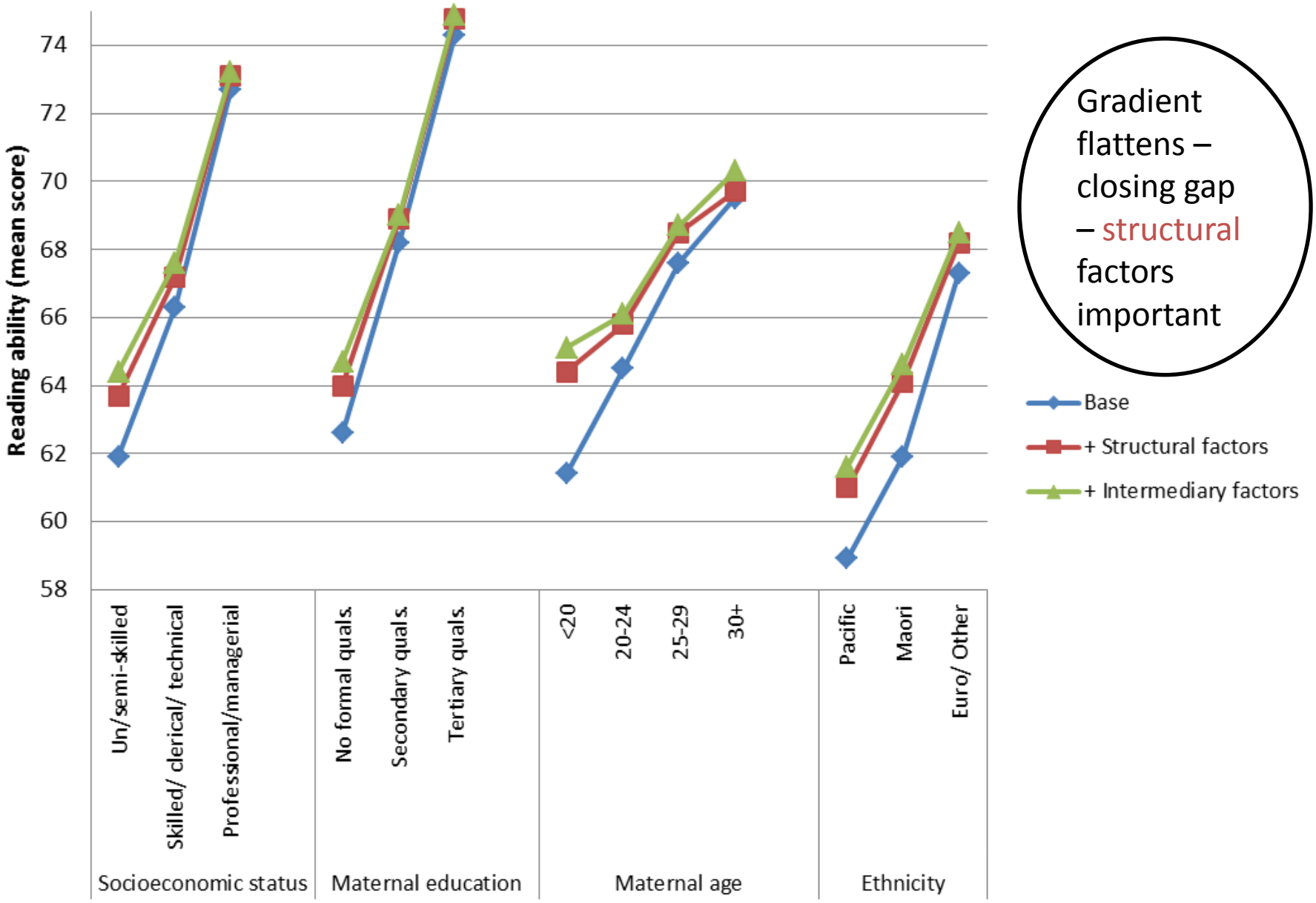
Increasing the reading score is interpreted as an improvement in outcome

Reading Ability. Disparities: absolute change



Watch this space

Reading Ability. Disparities: absolute change



Outcome: Conduct problems

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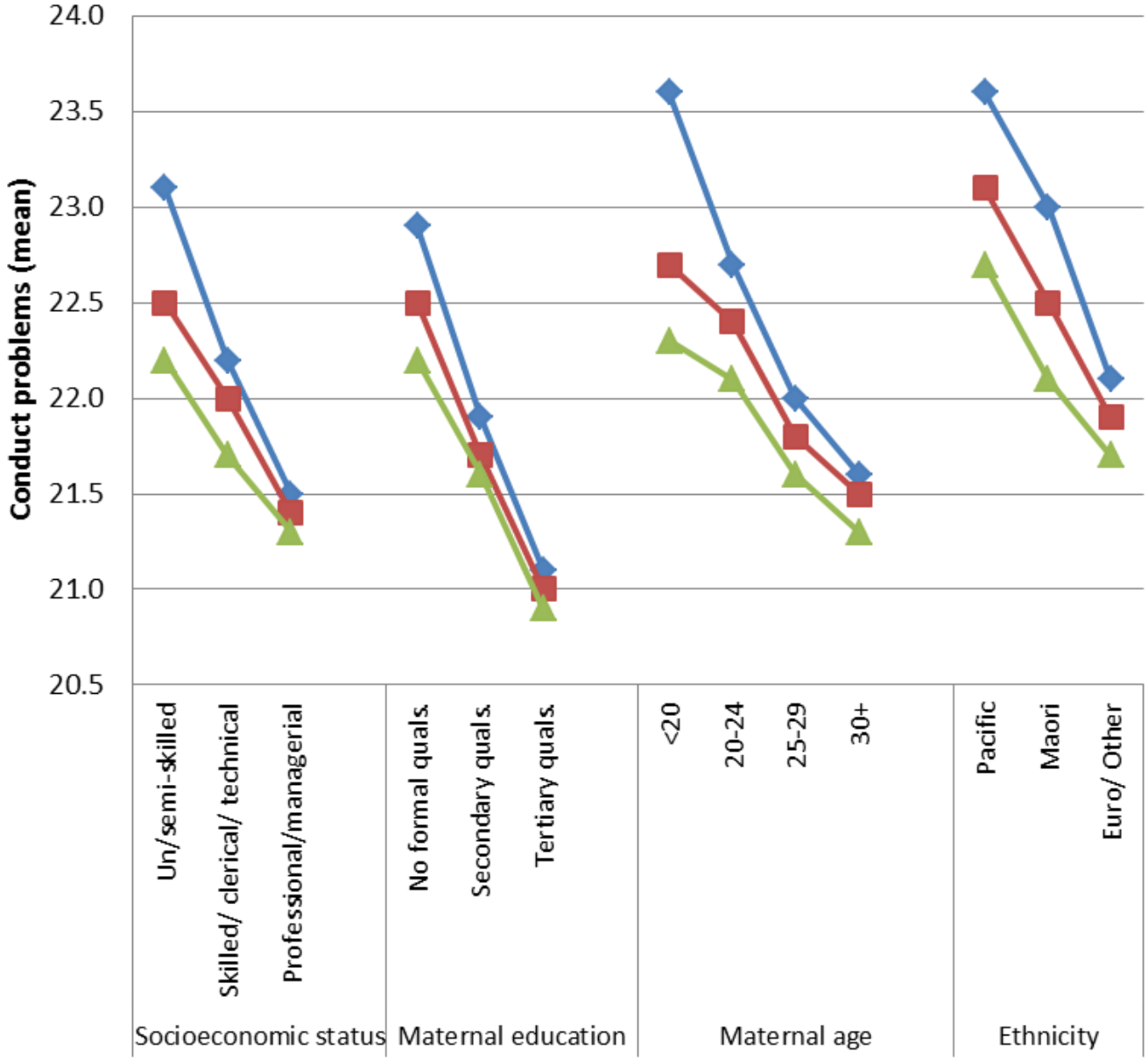
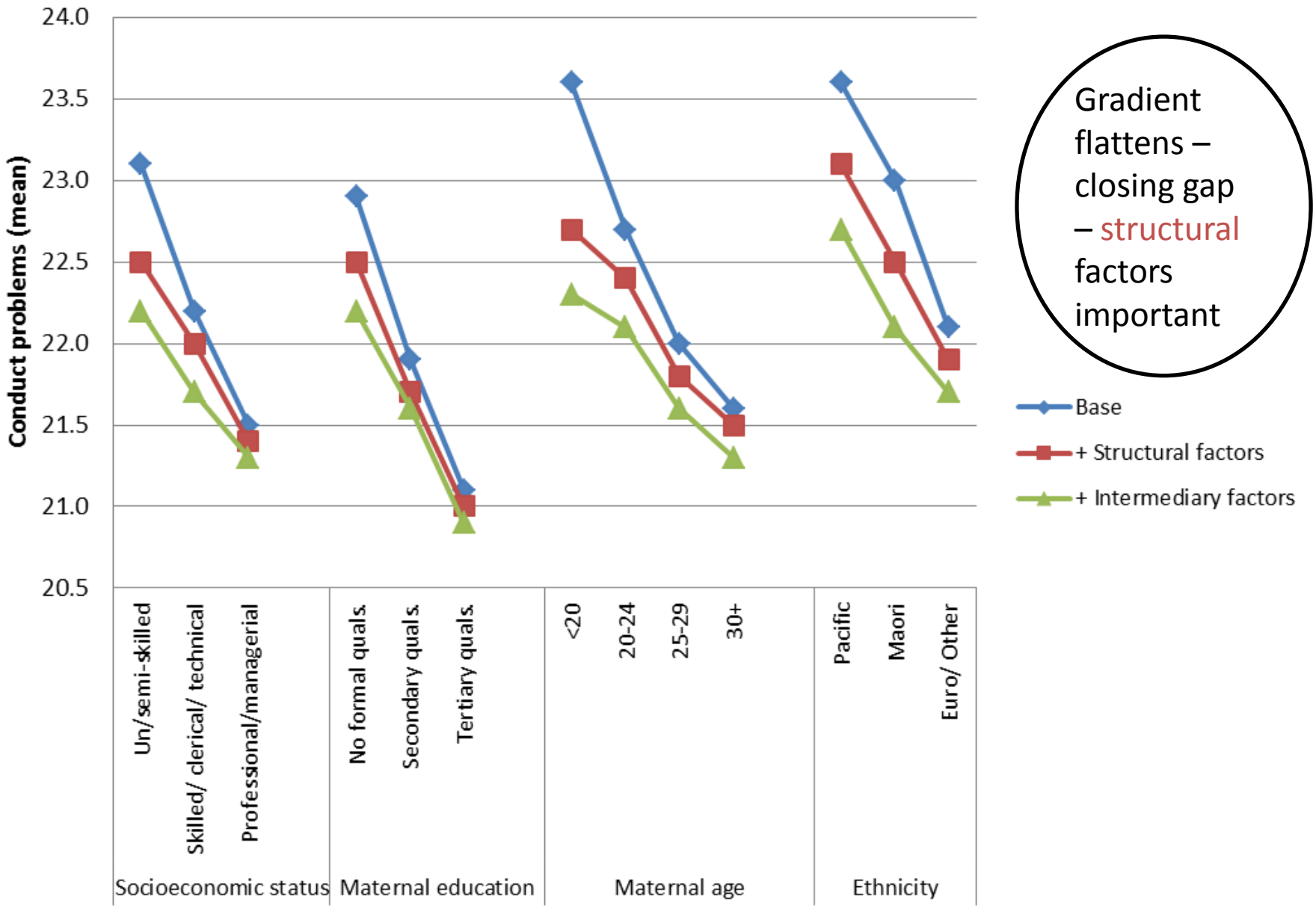
Reducing the number of conduct problems per year is interpreted as an improvement in outcome

Conduct Problems. Disparities: absolute change



Watch this space

Conduct Problems. Disparities: absolute change



Summary of results

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- Q1: Changing a single factor has slight effect on outcome - appreciable effect only by changing multiple factors
- Q2: Effect of modifiable structural factors is greater than of intermediary factors
- Q3: Clear social gradients - with progressively more positive effects on outcome as disadvantage increased
- Q4: Similar findings for range of outcomes in different domains

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Extension

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- Knowledge "laboratory" extension (2013-2016)

1. Reaffirm key determinants/important factors in model
2. Identify systematic reviews/meta-analyses on these
3. Insert parameter estimates into confirmed model
4. Validate model "runs" against external data
5. Test real-world policy scenarios (as per expert group)
6. Deploy/"test-run" inquiry system in policy settings

Conclusion

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- Computational social science has much to offer:
  - Can mimic social processes (e.g. life course trajectory)
  - Can address data shortcomings (e.g. sample size, data sources)
  - May also provide an approximation to causal analysis
- Micro-simulation and decision support/inquiry system
  - With the right empirical and conceptual “anchoring”, and working closely with colleagues in the policy process, our tool (KIWI) could be the basis of a more “evidence-informed” policy approach
- Future plans:
  - Insert effect estimates from the literature (knowledge “laboratory”)
  - Assess more complex interventions and outcomes
  - Improve causal power of underlying statistical analysis

Selected Research Outputs

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- Davis P. et al. (2010). Using micro-simulation to create a synthesised data set and test policy options, Health Policy , 97: 267-274.
- Davis P. (ed.) (2014). Data Inference in Observational Settings. Volumes I-IV. Sage, London.
- Lay-Yee R. et al. (under review). Determinants and disparities: A simulation approach to the case of child health care. Social Science and Medicine.
- Mannion O. et al. (2012). JAMSIM: A micro-simulation modelling policy tool, Journal of Artificial Societies and Social Simulation, 15(1)8.
- McLay J. et al. (in preparation). Statistical modelling techniques for dynamic micro-simulation: An empirical performance assessment.
- Milne B. et al. (2013) *Creating a synthetic starting population*. 4th. International Micro-simulation Association Conference, June 11-13, Canberra, Australia.
- Milne B. et al. (2014). A collaborative approach to bridging the research-policy gap, Evidence & Policy, 10 (1): 127-136.
- Pearson J. et al. (2010). Building and testing a micro-simulation model for policy purposes', Social Science Computer Review , 29(1): 21-36.